EMISSION REDUCTIONS AND SUSTAINABILITY ARE NOT ENOUGH TO ARREST CLIMATE CHANGE BEFORE THE MID-2030'S. ONLY THE NEGATIVE EMISSIONS TECHNOLOGIES ARE POWERFUL ENOUGH - BUT WE MUST MOVE SWIFTLY AND ON A MASSIVE SCALE BEFORE WE HIT THE *CLIMATE DEADLINE 2035*

"The suffering we are experiencing as a result of *the COVID-19 pandemic is yet another manifestation of Climate Change* (acting through alterations in human-animal disease vectors). Climate scientists have awaited a "*Climate Pearl Harbor*" which will awaken the public and politicians to the urgency and magnitude of our global warming plight….and here it is! But will we *awaken* and have the wisdom to *direct* our frustration with this deadly virus into the correct action? The path forward is an extremely narrow one and rapidly closing. We must *bypass the temptation* to rest in futuristic hopes of mitigation, carbon reduction and sustainability and instead mobilize the *Negative Emissions Technologies* (NET) of *Direct Air Carbon Capture* (DAC) and *Solar Radiation Management* (SRM) to deal first with existing *legacy emissions*. Only then can we be sustainable. Starting in 2025 we must *capture a net 10 GtC/yr (10 billion metric tons) average CO2 per year* if we hope to skirt the *twin points of no return* in the mid-2030's – 450 parts per million atmospheric carbon and 310 GtC of ocean-dissolved CO_2. (Inarguable geologic records demonstrate the former will trigger the Earth to shift to *a new normal inconsistent with human survival*. The latter will cause phytoplankton to *stop producing 80% of the world's oxygen*.) Existing legacy carbon is not going away because we stop adding more – not for up to thousands of years. *It must by actively removed*. What can you, or your organization do to restore your children's future-now-forfeit – use any avenues open to you - including joining the Climate Deadline Alliance (and the "Omnicide Complaint" now being reviewed by the International Criminal Court), pushing awareness of the necessity for a cooperative global effort to remove carbon from the atmosphere in your social groups, joining and advocating for NET in environmental organizations, supporting any ballot initiatives or candidates who are working for DAC/SRM, and contacting individuals with high visibility, connections, access and resources who can take action toward a global DAC/SRM effort. As in World War II everyone must be part of this effort. Do not delay, we need all hands on deck and time is short."

- Dr. Christian R. Komor

SUMMARY OF WHAT YOU NEED TO KNOW

(1) Since the industrial revolution, human activity has artificially released about 375 billion tons of carbon dioxide (CO_2) as well as megatons of other greenhouse gasses (GHG). The most prolific of these "legacy emissions", carbon dioxide, remains warming the atmosphere for thousands of years. Viruses like COVID-19 are only one results of the environmental damage from global warming. We have been fortunate, until recently, to have only suffered increasingly frequent adverse events. In 2020 COVID-19, hurricanes, economic turmoil, earthquakes and massive wildfires have happened all at the same time. This "worst year ever" is a small taste of what the future holds for our children as Climate Change advances. It will be a future filled with escalating pandemics, wildfires, hurricanes, mass migrations, flooding, drought, desertification, dying coral reefs, massive crop loss and famine, aquatic and land species extinction events (in particular amphibians, conifers, reef corals, sharks and rays, crustaceans, birds and mammals), and unsurvivable increases in mitigation costs and reduced GDP to try and keep pace with disasters.

(2) Five decades ago, in the early 1970's, governments and multinational corporations became aware that a buildup of greenhouse gasses in the atmosphere would eventually result in the end of most human life on Earth. At that time sustainability and emission reductions were recommended by scientists politicians and corporate heads and could have reduced global warming enough for the Earth to cycle greenhouse gasses out of the atmosphere, soil and oceans (variously taking hundreds to thousands of years). Instead governments allowed multinational corporations to continue to escalate Greenhouse Gas (GHG) emissions. (By the way, the first automobile and airplane engines were electric. The technology was developing rapidly and consumers were very

enthusiastic. Businesses, however, discovered it was more profitable to build and operate engines using internal combustion. Currently the top 1% of those wealthy business owners create more than double the carbon emissions of the bottom 50% of wage earners.)

(3) In the past two decades sustainability practices and emissions reductions technologies have been rapidly evolving so that global ecological sustainability seems possible in the future. Nations have set emissions goals which (if followed) will keep the situation from getting even worse…..*but this will have no impact on our present Climate Emergency*.

(4) Even if we were to *halt all GHG emissions immediately*, our warming trajectory combined with ocean and soil outgassing and cascading negative environmental feedback loops will continue for several centuries. In roughly the mid-2030;s this will push our planetary warming beyond the *Anthropocene Extinction Boundary* (450 ppm dissolved atmospheric carbon). At that point Earth will essentially "lock into a new normal" – one that is inconsistent with the continuation of human life. The evidence for this is geologic not a computer projection and as such has a near certainty of being accurate. As of 2019 the accumulated CO_2 concentration has passed 415 ppm leaving us perhaps 100 years from "the end of life as we know it", *but only 15 years from the "point of no return"* beyond which the few future generations remaining will have no power to change the outcome. The 2020 UN Climate Summit echoed this analysis with the statement that "by 2030….we will detonate a domino effect of ecosystem failures, one cascading on the other, that we will not be able to recover from." (Unfortunately, that same UN Summit focused on cheerfully lauding short-range "mitigation and adaptation" efforts which, unfortunately, will quickly be overwhelmed after we reach that point of "cascade failures".)

(5) There is therefore no remaining question that we will need to *artificially correct the artificially caused disruption in Earths ecological balance*. We are just simply out of time to do anything passive – we must be proactive and fight to remove existing legacy emissions so sustainability practices and Earth's own self-healing mechanisms can take effect. Thankfully, we now have the technology to do this by increasing the albedo, or reflectivity) of various parts of the Earth - called Solar Radiation Management (SRM) - and, or removing carbon directly from the atmosphere - called Direct Air Carbon Capture (DAC). These are called Negative Emissions Technologies. (Interestingly, the World Meteorological Agency found in late 2020 that, in spite of dramatic reductions in carbon emissions due to the 2020 world pandemic, atmospheric CO2 levels had continued to rise at the same rate.)

(6) The use of DAC/SRM Negative Emissions Technology will require a coordinated global effort such as we have not seen since World War II in a world that, shamefully, could not even get it together to wear masks to protect each other from a deadly pandemic. *International cooperation is the only essential missing piece in resolving our global Climate Change Emergency*, but given the increasing complexity and territoriality of international relations, the possibility of a coordinated carbon removal effort by the United Nations, governments, NGOs and, or multinational corporations is stalled. Unlike the "Greatest Generation" (my Grandparents), with few exceptions, people today have been unwilling to give up "business as usual" and short-term gratification – much less their lives – for this ultimate worthy of cause. Further scientific research and engineering innovations will be nice, but not necessary. The emergency that must be navigated right now through psychology, politics, sociology and common sense is bringing divergent international parties together to initiate SRM/DAC rapidly and on a global scale.

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WE ARE IN THE LAST FIFTEEN YEARS OF A CLIMATE EMERGENCY…..THEN THINGS GET REALLY BAD

In the fall of 2019 a few months before a world pandemic distracted our focus, the United Nations declared a Global Climate Emergency, but what emergency measures are possible when emissions reductions and renewable transitions lost the power to save us 40 years ago? Should we step back and let climate scientists continue to research the situation? Should we plant a garden in our backyard? Should be reduce our carbon footprint? Should

we invest in alternative energy? These things may make us feel good and provide a blueprint for sustainable life if we make it past the mid-2030's 450ppm atmospheric carbon deadline, they have not and will not interrupt the trajectory of global warming. Earth is choking on what we have fed Her and stuffing less in now does not equal removal of what is already cutting off Her air supply. Indeed, mitigation efforts create a kind of complacency: by voting for green candidates, riding a bicycle to work, avoiding air travel, you might feel that you've done everything you can. Whereas, if you accept the reality that the patient is already dead (e.g. on track to being unable to sustain most life now existing on Her) if we don't remove the blockage, there's a whole different set of actions you should be doing.

In parts of California, fire season is now 50 days longer than in 1979. Studies of the Western United States suggest that about 40 percent more area is burned today than would have in a world where climate conditions remained as they were in the 1980s.

The Great Barrier Reef and those like it are rapidly dying. Marine heatwaves that are radically transforming the undersea ecosystems and devastating fish stock. Glaciers are melting and, as of this writing, both north and south poles are now literally on fire. The Thwaites Glacier a chunk of ice the size of Florida, which, if it tumbles into the ocean, could raise sea levels by 10 feet.

As of 2020 nearly 21,000 monitored populations of mammals, fish, birds, reptiles and amphibians, encompassing almost 4,400 species around the world, have declined an average of 68% (1970 – 2016), according to the World Wildlife Fund. Species in Latin America and the Caribbean, as well as global freshwater habitats, were disproportionately impacted, declining, on average, 94% and 84%, respectively.) With the exception of Ozone, these emissions remain largely uncontrolled, though the suffering, death and financial expense being caused by Climate Change has already surpassed both World Wars and continues to escalate exponentially.

WE ALREADY HAVE THE TECHNOLOGY WE NEED TO REPAIR GLOBAL WARMING AND RESOLVE THE CLIMATE EMERGENCY

Global Warming is not a matter of opinion any more than the temperature at which water boils. Only research findings, and observational studies conducted by valid scientific organizations such as the American Association for the Advancement of Science, the American Geophysical Union, Oak Ridge National Laboratories, the American Meteorological Society, the American Physical Society, The Geological Society of America, the NASA Goddard Institute, the NOAA Climatic Data Center, the U.S. National Academy of Sciences, the U.S. Global Change Research Program and Environmental Protection Agency, and, of course, the Intergovernmental Panel on Climate Change have meaning and are worth discussion.

Governments and multi-national corporations have conducted their own research and been aware for decades of the potential of GHG accumulations to end most existing life on Earth. By contrast, as if it was a cosmic test of our fitness to continue as a species, we have been given all the pieces we need to solve the crisis all we need is international cooperation to put them to use. Can we overcome the fear and selfishness in our human nature to cooperate in a joint multinational carbon clean-up effort? It appears this will be our final exam as a species.

What we have now:

ONE: A keen awareness of the problem of Climate Change. In the USA nearly 90% of Americans polled believe the country should transition to emission-free renewable energy sources.

TWO: Knowledge of the timeline we are working under. Geologic records show that each time the Earth reaches the neighborhood of 450 parts per million atmospheric carbon (coming up in the mid-2030's) the planet locks into a new ecological balance unlike the one homosapiens evolved in.

THREE: Realization that without artificial removal of existing "legacy" carbon we cannot meet this deadline through emissions reduction, carbon credits, and sustainability measures. (We must augment emission reduction efforts by capturing a net 10 GtC/yr (10 billion metric tons) average CO_2 per year starting by 2025.)

FOUR: Financial and material resources to do the artificial removal of carbon through Solar Radiation Management (SRM) and Direct Air Carbon Capture (DAC).

What we are lacking is:

ONE: International cooperation which will allow us to engineer the SRM/DAC solutions we already have on a big enough scale to have the impact we need.

TWO: There is no two.

THE KEY ROLE OF PSYCHOLOGY IN REMEDIATING CLIMATE CHANGE

"Climate Science" did not really exist as a field of study until very recently and most of the professionals working in the field now came originally from other disciplines. At this point we are not lacking in natural sciences research or technology. In 2020 we are in need of input from the *social sciences*!

In spite of thousands of research studies, billions of dollars in grants, a broad range of innovations in greenhouse gas emissions reduction, major mitigation efforts, advanced sustainability solutions and entire organizations with massive payrolls devoted to environmental issues *our momentum toward the 2035 Climate Deadline of 450 ppm atmospheric CO_2 is increasing, not decreasing!* (If we had spent this long researching and conferencing about the Nazi Blitzkrieg, we would all be wearing swastikas.) We need action, we need it now, and the barriers to that action are at this point *psychosocial not technological*. The only hurdles are those which are preventing us from coordinated, collective action.

PANDEMICS AND A GLOBAL PERSPECTIVE

Dr. Anthony Fauci, the U.S. government's leading immunologist, warns that humanity is now entering a "pandemic era." "There are many examples where disease emergences reflect *our increasing inability to live in harmony with nature* and they are increasing in frequency and severity. When virus-carrying bats, for example, are forced to migrate into the territories of domestic animals, pandemics like COVID-19 are sparked.

And if you think COVID-19, with a fatality rate of about one percent is bad, wait until a prehistoric virus unleased by melting permafrost, or perhaps one of the *Nipah viruses*, with a fatality rate of 50 percent or higher, morphs in a way that allows asymptomatic transmission. Wait until *Crimean-Congo Hemorrhagic Fever* which causes Ebola-like bleeding out of every orifice of the body and is currently transmitted by Himalayan ticks, figures out a way to leap into Asian long-horned ticks, an invasive species that global warming has spreading wildly across North America. Want something even more in your face? As I write this, ten cities in Texas have shut down their municipal water supplies due to the presence of *Naegleria fowleri* a "brain-eating" parasite that typically infects people swimming in lakes and rivers. As freshwater lakes heat up, Naegleria fowleri are able to proliferate and, apparently, find their way into municipal water supplies.

Perhaps some good can come of the COVID-19 pandemic (sparked in large part by climate-driven intersection between humans and animal disease vectors) if we are forced to think globally and understand COVID-19 as the Pearl Harbor of Climate Change. We need to grasp the reality that cannot solve an *inter-national* problem like pandemics and Global Warming without collaborative *inter-national* solutions. We need to learn to get along, or nature will try again to find a species that will.

THE ANTHROPOCENE EXTINCTION BOUNDARY

A recent study using high-resolution past climate emulator, which provides temperature, rainfall, and other data over the last 5 million years found that past "generations" of Homo sapiens (including H. habilis, H. ergaster, H. erectus, H. heidelbergensis, H. neanderthalensis, and H. sapiens), could not survive intense climate change. The researchers looked at extensive fossil database spanning more than 2,750 archaeological records to model the evolution of each Homo species' climatic niche just before going extinct.

Lead researcher Dr. Raia Pasquale observed, "It was crystal clear, for the extinct species and for them only, that climatic conditions were just too extreme for adaptation just before extinction and only in that particular moment. It is worrisome to discover that our ancestors, which were no less impressive in terms of mental power as compared to any other species on Earth, could not resist climate change," he said. "And we found this just as our own species is sawing the branch we're sitting on by causing climate change." (Pasquale Raia et al. Past Extinctions of Homo Species Coincided with Increased Vulnerability to Climatic Change. One Earth. Published:October 15, 2020. DOI: 10.1016/j.oneear.2020.09.007)

Present-day Homo sapiens have been sawing their branch from the tree of life remarkably rapidly. Since the industrial revolution, human activity has released about 375 billion tons of carbon dioxide (CO_2) as well as staggering amounts of other greenhouse gasses (GHG) including: Ozone (O_3), Methane (CH_4) – alarmingly massive stores of which have recently begun to bubble up in polar seas where concentrations are now 8 times higher than normal - Nitrous Oxide (N_20), and the various Fluorocarbons (CFCs). Carbon dioxide, the most prolific of these "legacy emissions" remains in the atmosphere for thousands of years. We are continuing to emit 10GtC each year. Approximately 50% remains in the atmosphere while 30% is stored in the ocean as carbonic acid and 20% in the spoil. This uptake of carbon dioxide in the oceans has led to an increase in ocean acidity.

Indisputable geologic records show that each time (due to asteroid strikes or small changes in the Earth's orbit) our planet has reached 450 ppm atmospheric carbon (on our current trajectory this will occur in the mid-2030's) interactive feed-back loops in the environment have locked into a "new normal". We will have passed a "point of no return", the *Anthropocene Extinction Boundary*.

Indicators of this shift to a "new normal" are numerous and already occurring including:

- The slowing and redirection of ocean currents which distribute heat around the planet.
- The melting of ice and permafrost at both poles leading to…...
- The release of vast stores of methane from beneath melting permafrost and ice. Greenland has lost over 500 billion tons of ice in the past 10 years alone.
- Unbelievably, *arctic wildfires*. The peak number of active fire observations was about 600 in late July 2020, compared with 400 in 2019. In June and July 2020 alone NASA estimated that *205 megatons of CO_2* were emitted from these fires. Wildfires coincided with a heatwave *in Siberia*, where temperatures soared to more than 30C (86F) in some areas.
- Reduced or destroyed animal species and habitats such as during the Australian wildfires of 2019.
- Emergence of new soil microbes which have begun to release increasing amounts of stored carbon from the ground.
- A fatal breech between plants and pollinators.
- Increased wildfires throughout the world (to worst effect in rainforests) releasing massive amounts of carbon into the atmosphere.
- Altered weather patterns leading to loss of life and costly infrastructure damage.
- Vastly worsening insect borne disease vectors
- Increasing prevalence and intensity of viral and other diseases due to altered animal/human interactions.

The *interaction* between these variables has created *exponentially-increasing* changes in our planetary ecology (demonstrating again that nature cannot be viewed as isolated parts). Climate scientists have a track records of consistently *underestimating* the magnitude and speed of global warming. L*inear* projections of the progression of Climate Change cannot help but be inaccurate. Nature does not follow straight lines nor does she work in fragmented parts.

ELEMENTS OF AN INCREASINGLY FORESHORTENED TIMELINE

Floating near the surface of the water and absorbing the sun's rays, phytoplankton produce approximately between 60-80% percent of Earth's oxygen. More acidic waters make it difficult for phytoplankton to absorb nutrients, rendering them vulnerable to disease and toxins. Researchers from MIT and elsewhere have projected that - at around 310 GtC - increased ocean acidity will lead to a critical impairment in phytoplankton blooming in oceans. Daniel Rothman of M.I.T. and other researchers have calculated that, beyond that point, we will trigger the sixth mass extinction of land and ocean-based animals just by ocean acidification alone when phytoplankton stop producing oxygen. We are currently at 150 GtC of ocean dissolved CO_2 and that number is growing at 2 GtC each year. So, if 450 ppm atmospheric carbon dioxide doesn't end us 310 GtC driven ocean acidification will.

As if this specter was not bad enough, acting according to Henrys Law, both ocean and land carbon stockpiles continually seek to maintain homeostasis. Thus, even when we *do* begin reducing legacy carbon through SRM/DAC this will *initially result in increased outgassing* of those carbon emissions we have been packing into the soil and oceans for the past hundred years. It will appear, at first, as if we are making little progress. As we start to remove atmospheric carbon it will only come out at half the anticipated rate (until the we are down to about 10%). This effect will "slow" the progress of atmospheric carbon reduction meaning we have to start sooner and more aggressively.

And if *that* wasn't bad enough, some current emissions reduction/sustainability measures can be actively harmful. For example, sulfate aerosols, largely from coal-fired power plants with inadequate pollution controls, *actually have a global cooling influence*, with the effect is most pronounced over large parts of the Northern Hemisphere. Efforts in many countries to rapidly reduce these emissions, while beneficial in the long run, will inadvertently work to drive us faster toward the Anthropocene Extinction Boundary of 450 ppm atmospheric carbon dioxide and 310 GtC driven ocean acidification.

TOO LATE FOR MITIGATION, PERSEVERANCE, INNOVATION AND EMISSIONS REDUCTIONS WHICH ARE *OMNICIDAL* AS STAND-ALONE CONCEPTS

In the 1970's we could have discontinued greenhouse gas emissions, transitioned to alternative energy sources, and simply waited for the Earth to cycle greenhouse gasses out of the atmosphere. In 2020, even if we were to halt all GHG emissions immediately, our warming trajectory would still push our planetary ecology beyond the Anthropocene Extinction Boundary in the mid-2030s.

Hopes that shifting to renewable energy and sustainability practices combined with mitigation and adaptation to climate disruption are not only fruitless but, *more critically, are creating a lethal confusion and wasting resources and time* we urgently require for making repairs to our atmosphere. We are making short-term "wins" and losing the fight. We must first remove enough legacy atmospheric carbon to get us below 350 ppm and then "sustain". We must shift our thinking, remembering we have artificially created a large problem and will need to artificially remove the problem before perseverance, innovation, sustainability, and adaptation can occur more naturalistically.

Perseverance - We cannot hold out forever with nature itself turned against us.

Innovation - We already have the technology needed to repair the problem.

Sustainability – There will be nothing to sustain if we don't make it past the 450ppm Climate Deadline.

Adaptation - to Climate Change is possible only on a very short-term basis and is a losing scenario. It doesn't matter how tough you are. As every schoolchild knows, you can't fight Mother Nature.

As things stand now, we must *actively* remove emissions in the air *in addition to* rapidly reducing emissions on the ground, or watch most of life perish within this century. We must support nature in recovering from the damages we have artificially inflicted and to do so we must utilize artificially derived methodology. The time for moaning and gnashing of teeth over the dangers of Negative Emissions Technologies has passed. We no longer have time for such armchair niceties. Funding and decision making currently directed toward adaptation and mitigation must necessarily and rapidly be refocused on the large-scale deployment of Negative Emissions Technologies like DAC and SRM.

NEGATIVE EMISSIONS TECHNOLOGIES (DAC & SRM)

Negative-Emissions Technologies (NET) have been discussed by climate scientists in academic journals for many years. They can be divided into two general groups, Solar Radiation Management (SRM) and Direct Air Carbon Capture (DAC) which is sometimes, confusingly, and less accurately, referred to as Direct Air Capture. DAC has been researched in the form of *Land-Based Carbon Removal (LBCR), and Ocean-Based Carbon Removal (OBCR).*

The use of NET will require *a concerted global effort* such as we have not seen since World War II. Given the increasing complexity and territoriality of international relations - coordinated carbon removal efforts by the United Nations, governments, NGOs, and multinational corporations are currently stalled. Everyone is focused on their own endeavors and the next grant application. It is as if, having determined the Nazi regime to be a threat, each individual province and state of each country rushed off in complete discoordination with its own plan to defeat Hitler. You can imagine what would have happened – much energy expended with no results.

The safest and most scalable methodology for NET appears to be that developed Robert R. Fry, Ph.D. Fry and his partners at Climate Restoration Technologist in North Dakota. CRT has developed an elegant and nature-sensitive plan called Ocean Assisted Carbon Capture & Reflection or OACC&R. Fry's team's intent is to leverage the vast resources of nature herself (for example increasing the rate at which some ocean animals consume CO2) to repair the damage caused by humans using ocean life as a springboard.

Carbon Engineering's David Keith, Ph.D. has written on both SRM and DAC and recently built a DAC plant in Canada. Keith and his team have demonstrated their technology could atmospheric capture carbon dioxide for between $100 and $250 per metric ton. They have had generous start-up grants from the likes of The Bill and Linda Gates Foundation and the Canadian Government and are now partnering with US oil giant Occidental Petroleum to scale-up their existing DAC test plant. By 2022 CE/Oxy hope to have a plant up and running in the Permian Basin that will capture and bury 500,000 metric tons of carbon each year and actually turn a profit. (Previously, a 2011 study by the American Physical Society had predicted DAC technology could cost more than $600 per metric ton. For context, the highest global price on carbon emissions—as a tax or a tradable credit—is around $200 per ton.)

Building a carbon capture plant is not as difficult as it sounds. Carbon "scrubbing" systems have been used in submarines for a long time. CO_2 scrubbers use a regenerative liquid absorbent to remove carbon dioxide continuously from a submarine's atmosphere using a regenerative liquid absorbent. Similarly, in a DAC plant, a large fan sucks in huge volumes of air and passes it over corrugated sheets. A chemical solution, which reacts with carbon dioxide in the air, is poured onto the sheets. The carbon-rich solution is then transported to a container where it is brought in contact with quicklime (or calcium oxide) that reacts with the mixture to form pellets of limestone (or calcium carbonate). In a third container, these limestone pellets are heated to about 1000°C to create quicklime that can be reused and release carbon dioxide as a pure stream of gas. The greenhouse gas can then be injected underground in depleted gas fields or converted into something useful.

It may be necessary to combine other carbon removal strategies such as afforestation and ocean-based carbon capture with the technologizes of DAC – like a blended stock portfolio. Different approaches will likely be more efficient in different parts of the world. For example, research has shown that afforestation and reforestation will be most productive in tropical regions, whereas SRM differences in the more northern latitudes with more albedo (reflection of light back into space) mean those countries will likely have better luck investing in the more technological interventions, such as carbon capture and biomass extraction. Dr. Robert Fry at Carbon Repair Technologies suggests a four-pronged approach will be needed. Fry would include ocean amplified carbon capture (OACC) via selective algal blooming with a novel approach to: maximal export to seafloor (MES) approaching 100% @ 10 GtC/yr, 90% emissions cuts by 2080, a 1.8% increase in planetary albedo by 2040, maintaining that albedo cooling steadily (but on a declining schedule which steadily reduces albedo (correspondingly) as CO2 drawdown progresses toward final targets (to maintain the preindustrial temperature after 2040 until the final CO2 targets are reached), plus means of regionally & seasonally super-cooling vulnerable polar ice (and surrounding seas) to stabilize it and halt its slide into the sea.

INTERNATIONAL COOPERATION AND SCALABILITY

Recently results published in the Proceedings of the National Academy of Sciences suggested that geoengineering could work, but only up to a certain point. If greenhouse gasses are not curbed, they will rise to levels that would have a negative impact on stratocumulus clouds, making them thin, and in some cases, eliminating them. Without this cloud cover, even the introduction of particles into the atmosphere would not be enough to prevent global warming. They suggest that geoengineering would not be a solution that some have proposed if levels of greenhouse gas emissions are not reduced. We have waited so long we now much work the problem at both ends. Of course, most people are still just "feeling concerned" and not actually doing anything.

INTERNATIONAL COOPERATION AND SCALABILITY

By the year 2025 we need to be removing at least 10 GtC/yr billion metric tons from the atmosphere in addition to fairly strenuous emissions reductions. Global CO_2 emissions are currently exceeding 10 GtC/yr. A 12 GtC/yr cap is recommended by 2023. A realistic schedule would feature subsequent emissions reductions to 10.5 GtC/yr by 2030 - 6 GtC/yr by 2050 - 3 GtC/yr by2062 - and 1 GtC/yr by 2078. (Developing countries would necessarily receive more of a grace period, beginning or accelerating their emissions cuts in 2063.)

Unfortunately, with all its backing, ivy league credentials, and Big Oil connections even our leading carbon-eaters at Carbon Engineering (above) are essentially only presenting *a 1 GtCO2/yr solution for a 4,000 GtCO2 cumulative problem*. That would mean it would take 4,000 years to get us into a safe zone (below 350 ppm)….and we have maybe 15 years at best. *Instead of 1 GtCO2/yr solutions, we need 37 GtCO2/yr solutions* (the equivalent of 10 GtC/yr). The Occidental-Carbon Engineering goal of 500,000 metric tons per year is a tiny fraction of that 10 Gigatons per year (37 GtCO2/yr) of legacy atmospheric carbon removal needed by 2025. Thus, by that year the CE-Oxy Permian Basin plant will need to have *20,000 identical siblings plants* located at strategic sites around the world to avoid the 450ppm atmospheric "Climate Deadline" in the mid-2030's. One has to wonder if CE-Oxy are aware of the deadline magnitude problems involved and have a plan for addressing them, or are they just engaged in another profit-driven scheme to maximize oil field yields.

The nutshell take-away? No matter how bright and innovative the technology, *we will still need a coordinated international effort to scale it large enough to repair the climate problem in time.* Certainly, no organization will, on its own, create 20,000 carbon capture facilities scattered around the world to see us through the Climate Crisis. As in World War II, the small economy of Britain was unable to accomplish the massive task of confronting combined challenges from Germany and Japan. Victory required a collaborative effort between several allied countries. So it will be with Climate Change – but will we realize soon enough the course we must follow?

[Reminder: It is important to observe which scale is being used to describe carbon removal efforts. For example, when expressed on paper 1 trillion metric tons (the carbon measure) is equal to 4 trillion metric tons (the CO_2 measure). 1 GtC = 3.67 $GtCO_2$, so 1,100 GtC = 1.1 trillion metric tons (carbon measure) = 1.1 tera-tones (carbon measure) = 4 tera-tones CO_2.]

COUNTING THE COSTS

In the past decade test plants have been able to reduce Direct Air Capture costs by more than two thirds. Dr. Keith's group reported in *Joule* that when CO_2 was delivered at 15 MPa, the design required either 8.81 GJ of natural gas, or 5.25 GJ of gas and 366 kWhr of electricity, per ton of CO_2 captured. Depending on financial assumptions, energy costs, and the specific choice of inputs and outputs, the levelized cost per ton CO_2 captured from the atmosphere ranged from $94 to $232 /t-$CO_2$.

Compare these costs to the radical destabilization of life on earth already in-process due to Climate Change — massive crop failures, apocalyptic fires, imploding economies, epic flooding, hundreds of millions of refugees fleeing regions made uninhabitable by extreme heat or permanent drought. A United States government report in November 2018 predicated US GDP going down 10% as a result of the warming climate, including huge shifts in geography, demographics and technology. In 2019 costs for mitigating severe weather damages attributable to climate change alone passed the $100 billion mark. In 2020 the World Economic Forum ranked climate change as the biggest risk to economy and society.

SOLAR RADIATION MANAGEMENT WILL ALMOST CERTAINLY BE NECESSARY

Because we have waited so long to take action, a limited and temporary deployment of Solar Radiation Management (SRM) albedo modification techniques will almost certainly be necessary to avoid hitting the Anthropocene Extinction Boundary. There are at least half a dozen well-researched types of global albedo modification from cloud seeding, to aerosol injection, to solar space shielding or EHUX algae blooms However, at the present time there are strong international concerns about the safety of albedo modification. *Partial* deployment of *several* planetary whitening interventions *different enough* from one another simultaneously might reduce fears of triggering unintended adverse effects. We will have to overcome our fears – to do nothing is not an option.

Stratospheric aerosol injection involves increasing the amount of small reflecting particles (aerosols) in the stratosphere. The stratosphere is a layer in the upper regions of the atmosphere (starting at approximately 18 km altitude in the tropics) above the more turbulent troposphere layer where rainfall and most conventional "weather" occurs. The aerosol increase is generally not accomplished by injecting aerosols themselves, but by injecting chemical precursors which transform into aerosols via subsequent processes. Probably the safest material considered so far be researchers is chalk dust. Sulphuric acid has known adverse consequences and will not work,

Another well-researched method of albedo modification is *marine cloud brightening* involving injecting substances near the surface of Earth that increase the reflectivity of low cloud layers. The emphasis is generally on clouds over the ocean (which has a low albedo), because these present the best opportunities for increasing reflectivity.

But even if preindustrial temperatures are restored by 2035 through increasing the Earth's albedo, *CO_2 must still be drawn down*. If not, legacy CO_2 will still continue its relentless warming effect once albedo modification is removed, and somewhere between now and 2100 we will reach an ocean acidity tipping point (310 GtC of ocean-dissolved CO_2) leading to a lack of oxygen. We also do not know the consequences of maintaining reduced temperatures while leaving increasingly high levels of greenhouse gasses. Our only real choice is DAC with the possible *addition* of SRM if our time window grows too small.

"CARBON CAPTURE AND SEQUESTRATION" (CCS) IS NOT THE SAME AS DIRECT ATMOSPHERIC REMOVAL OF EXCESS CARBON (DAC)

In 2020 fully 67% of global energy is still being supplied by fossil fuels. Major efforts are being made to capture some of the carbon emissions at the source from these plants. The current approach is to pressurize this to 11,000psi and bury in deep subterranean porous silicate rock structures. Unfortunately, there are not enough of these porous rock areas to go around so CCS power plants can only be located in a very few places potentially leaving billions of tons of CO_2 to be delt with.

REMAINING STUCK IN "BUISNESS AS USUAL" IN THESE CONDITIONS IS AS INAPPROPRIATE AND COWARDLY AS A SOLDIER DESERTING DURING BATTLE

It is a capitol mistake to approach Global Warming with a "business as usual" mindset. Without a functioning biosphere, all of human effort will be rendered palliative at best and of less and less importance as the level of human and wildlife suffering increases. This is not just another genocidal dictator. It is the endgame for the current expression of much of sentient life on this planet.

Those in key roles on the international stage must become willing to step outside the confines of their standard duties and attempt the possible. If not, all is lost and we must trudge on each day knowing our work is only marking time, making ourselves as comfortable as possible while the inevitability of Climate Change closes in around us.

Informed by this awareness of the *Clear and Present Danger of Global Warming*, we must find the strength and determination to shift from our current "business as usual" approach to human endeavors and adopt a "war footing". We must quickly build the *severe and unrelenting resolve* needed to act affirmatively to remediate Global Warming – whatever the costs.

WHAT YOU CAN DO NOW TO SAVE YOUR CHILDREN'S FUTURE

1) Support a Lead Organization to Direct and Manage SRM / DAC. Some possible options are:

- The United Nations with its many organizations, funds, programs, and specialized agencies
- North Atlantic Treaty Organization (NATO)
- European Union (EU)
- World Trade Organization (WTO)
- Group of Twenty (G20)
- International Criminal Court (ICC)
- International Energy Agency
- International Renewable Energy Agency (IRENA)
- Sustainable Energy for All (SE4ALL)
- Renewable Energy and Energy Efficiency Partnership (REEEP)
- International Solar Alliance
- The World Meteorological Organization
- International Energy Agency (IEA)
- International Monetary Fund (IMF)
- Organization for Economic and Co-operation Development (OECD)
- OPEC Fund for International Development (OPEC Fund)
- Organization of Petroleum-Exporting Countries (OPEC)
- World Bank Group
- International Development Association (IDA)
- World Trade Organization (WTO)

2) Work to push the United Nations to take action on its rhetoric regarding Global Warming. In the decades the UN has been aware of the greenhouse gas accumulation problem and holding various levels of discussions on the subject (e.g., the 1992 Rio Summit, the 1997 Kyoto Protocol, and the 2015 Paris Agreement as well as scores of other global assemblies), greenhouse gas concentrations have continued rapidly rising, with increasingly damaging effects on the Earth's climate. In order to make the work of the United Nations effective in addressing Climate Change, elements of the United Nations - including the *UN Environmental Assembly (UNEA) and the United Nations Environmental Program (UNEP) -may need to be modified* so that they have the necessary representation, primacy, administration, enforcement, regulatory capacity and sense of urgency to complete this work.

3) Write, call or FAX the International Criminal Court! Located in the Hauge, Netherlands. The International Criminal Court has the jurisdiction to prosecute individuals for the international crimes of genocide, crimes against humanity, war crimes, and the crime of aggression. As of February 2020, the ICC has in their possession a Complaint against the Canadian Government alleging the crime of "omnicide". (Omnicide is defined as a crime against humanity. For example, omnicide would be the result of nuclear war.) *Carbon – like nuclear material – can be and has been used as a chemical weapon and its release on a population fits the definition for a Weapon of Mass Destruction (WMD).* All concerned parties including environmental organizations, philanthropists, government agencies, media and private individuals must be asking the ICC to investigate and prosecute Canada for omnicide, and that Canada make reparations by deploying its existing Direct Air Carbon Capture technology. The ICC is currently the most effective pathway open to us for fighting the Climate Emergency declared by the United Nations in 2019.

Office of the Prosecutor
Post Office Box 19519
2500 CM The Hague
The Netherlands
otp.informationdesk@icc-cpi.int
+31 (0) 70 515 80 71
+31 (0) 70 515 88 98
Fax +31 70 515 8555

Liaison Office to the UN
Liaison Office of the International Criminal Court
to the United Nations
Head of the Office
Ms Karen Mosoti
866 United Nations Plaza, Suite 476
New York NY 10017
Tel: 1 212 486 1346/47/62
Fax: 1 212 486 1361

4) Contact your representatives in the Federal and State House and Senate to demand a committee to explore SRM/DAC as a safe, rapid, and effective solution to global warming.

5) Make a donation of $25, $50, $75 or $100 to support the effort to promote DAC/SRM through the Climate Deadline Alliance at www.climatedeadline2035.com or write climaterepair@protonmail.com

6) Cut and paste the information here and share about DAC/SRM on all your social media networks. If you have an email list of friends and family send them. (So many people today are feeling hopeless and fearful regarding Climate Change. You will be doing a great service letting those you care about know there is something they can do to solve the problem.)

7) Write an article, blog, or letter to the editor for your workplace or social group or even your local newspaper.

8) Visit our sister site at www.climatedeadline.com to get bumper stickers, baseball caps and other DAC/SRM merchandise.

9) Younger people are waking up to the travesty Climate Change means for them. Speak to them and offer what hope there is. We do have the knowledge and ability to repair this problem. The public needs to know what to push for (Negative Emissions Technologies) and then to push HARD.

10) If you have contact with a high-visibility individual (a movie or recording artist or other famous person) talk to them about what they can do to promote SRM/DAC and, or refer them to talk with our team.

12) Fossil fuel companies are crucial. They have the resources and the duty to implement DAC/SRM. They know resources are running out and are the feeling pressure. Converting their use from the conventional "dirty" consumption to 90 percent efficient CCS consumption would benefit everyone. Currently Occidental and Sunoco are the only oil companies that have signed the CERES (*Coalition for Environmentally Responsible Economies*) principles, is a Global Sullivan Principles Signatory, and has a non-discrimination policy. Sunoco is also a BELC (Business Environmental Leadership Council) member, and they have officially stated that they acknowledge that Climate Change is affecting our planet adversely. Some companies including the very progressive Occidental Petroleum has now formed the *Oil and Gas Climate Initiative*, banding together with 12 other oil companies that are focused on cutting emissions and looking to spend more than $1 billion to develop greener technologies. (By contrast, a Harvard University analysis of hundreds of ExxonMobil documents found that the company deliberately tried to hide the truth about the direct connection between carbon emissions and global warming.)

13) Most climate-related organizations are still stuck in the renewable-sustainable version of the future that is, as we have seen, is *not* going to work and is distracting from the real solution of Negative Emissions Technologies. If you have the opportunity to join one of these groups share with them what you have learned from the Climate Deadline Alliance. Convince them to start an exploratory committee or to immediately push for the establishment of a program for Direct Air Carbon Capture and Solar Radiation Management. Lobby them towards Negative Emissions Technologies and explain why this is our only solution in the context of international cooperation! The United Nations, the International Criminal Court and other organizations can coordinate to develop structures and operations leading to the effective use of Climate Engineering and for the rapid initiation of such a program.

American Farmland Trust
American Forests
American Horticultural Society
American Oceans Campaign
American Rivers
African Wildlife Federation
Center for Marine Conservation
Chicago Wilderness
Citizens' Environmental Coalition
Climate Mobilization
Climate Strike
Defenders of Wildlife
Earthhope Action Network
EarthJustice
Extinction Rebellion
Environmental Defense
Environmental Working Group
Extinction Rebellion XR
Friends of the Earth
Greenpeace USA
International Wildlife Coalition
LEAD International
League of Conservation Voters
Museum of Science, Boston,
National Audubon Society
National Environmental Trust
National Geographic Society
National Parks Conservation Association
National Religious Partnership for the Environment
National Resources Defense Council
National Tribal Environmental Council
National Wildlife Federation
Nature and Environmental Writers
Nature Conservancy
New Mexico Environment Law Center
Orion Society
Physicians for Social Responsibility
Rainforest Action Network
Sierra Club
Student Environmental Action Coalition (SEAC)
Sunrise Movement
Trust for Public Land
Union of Concerned Scientists
Wilderness Society

Wildlife Conservation Society
World Resources Institute
World Watch Institute
World Wildlife Fund

14) Support the Climate Deadline Alliance's *Colorado Direct Atmospheric Carbon Removal Initiative* which is being prepared for the next election cycle. Learn more at www.climatedeadline alliance.com

POST-CARBON REMOVAL

Once (and if) the current Climate Emergency is resolved (e.g. legacy carbon emissions returned to below 350 ppm and oceans returned to a balanced Ph), we must then have the resolve to judiciously *withhold additional use of Climate Engineering technology* until, operating through the United Nations, new ethics and agreements between governments for working with our planet's systems (rather than abusing, degrading and damaging them), and for establishing carbon neutral, equitable and sustainable practices can be put in place. *This will necessarily include adoption of alternative sources of energy, and population and resource management. We will essentially need to learn to regulate ourselves within the ecological limits of our planet* as well as we have learned to develop our freedom, independence, and ambition.

It is extremely dangerous, however, to *delay* deploying Negative Emissions Technologies while hoping for such political and social changes to take effect. Our "Climate Pearl Harbor" has happened. It's time to wake up, get organized, and realize that each and every one of us can and must make a difference.

ABOUT DR CHRISTIAN R. KOMOR

The Director of the Climate Deadline Alliance, Dr. Christian R. Komor, began a 30-year career in public service after graduating Magna Cum Laude from Wright State University in 1989. He is the author of numerous books translated into multiple languages including "The Power of Being" (1992), "Driving Ourselves Sane" (2012) and "Climate Deadline 2035" (2017). The release of Dr. Komor's first book, "The Power of Being" (1992) provided a forewarning of, and solutions for, the crisis of escalating consumerism and excess which now threatens our global way of life in the form of Climate Change. As a sought after national speaker and lecturer Dr. Komor has been the focus of dozens of articles, and television and radio interviews. Originally a native of Michigan, Dr. Komor migrated to the American Southwest in the early 2000's falling in love with the diversity of the land and people.

In 2016-2017 Dr. Komor trained with Al Gores "Climate Reality" team which then led to work with and a group of senior scientists and nuclear engineers working for the past dozen years on negative emissions technologies. In late 2017 he published the first edition of "Climate Deadline 2035" a harbinger of what the United Nations has since called the "climate emergency". In January 2018 Dr. Komor announced his run for Arizona Governor running on a Climate Change platform in order to gain public awareness for SRM/DAC and the potential to restore our atmosphere to its pre-industrial condition.

In early 2019 Dr. Komor became the Chief Litigant in a US District Court lawsuit on climate which eventually became part of the largest civil action to date addressing global warming.

In 2019 Chris founded the Climate Deadline Alliance (CDA). The Climate Deadline Alliance (CDA) predicts and disseminates next-level solutions to the Climate Emergency, providing key players with next-right-action models. All Climate Deadline Alliance work is pro-bono.

In early 2020 Dr. Komor's "Omnicide Brief" was accepted by the International Criminal Court and is currently under review there.

Dr. Komor can be reached at climaterepair@protonmail.com